

# **IBM Industry Models for Healthcare**

## **Healthcare Provider Data Warehouse**



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# Executive Summary

## IBM Healthcare Provider Data Warehouse is a blueprint for delivering comprehensive health analytics and insights

**The healthcare industry is undergoing rapid change in response to pressures to reduce total costs while simultaneously improving care outcomes for the patient population.** As the transformation to a patient centric and collaborative business model continues to gain momentum, the health care industry is expected to rapidly change to a more cost efficient and higher quality delivery system. Legislative reforms like the Patient Protection and Affordable Care Act (PPACA) 2010 are accelerating the pace of change. The achievement of these goals can be constrained by the availability of resources and limited budgets. It is critical, therefore, that the healthcare provider maximize the allocation of these resources to patient care and minimize the administrative overhead associated with the provision of services and compliance with rapidly changing regulations.

**Strategic and operational leaders need reliable and accessible information to prioritize and allocate funding, resources, and technology to remain competitive and ensure compliance with regulatory quality measurements.** They are challenged to aggregate the data they need to make key business and operational decisions to improve performance across complex environments. They are unable to calculate the true cost of care if they cannot correlate data that describes the resources and cost of care provided with patient outcomes and post-discharge patient satisfaction.

**Most healthcare providers do not have a detailed roadmap for bridging how clinical and financial data in order to correlate to the creation of these insights.** They lack the cross-functional expertise, resources and processes to design a comprehensive foundation for business intelligence. Attempting to develop this themselves is expensive and is unlikely to yield results within the necessary timelines for regulatory compliance and business goals. Packaged business intelligence solutions may not support technology investments already made, and may require an application specific and rigid data model.

Clinical EHRs, when integrated with resource utilization, activity based costing, billing and claims data, will provide the comprehensive analytics framework to enable historical analysis, predictive modeling and data driven decisions.



**Providers need innovative solutions that can lay the foundation for a broad range of analytical activities that can effectively integrate and analyze information from a wide range of data sources.**

**Faced with so many challenges, healthcare providers have responded by increasing investments in upgrading the information management and business analytics systems.** They are seeking to gain critical business insights by implementing measurements and effective decision making. These new analytics systems need to be robust enough to support current needs and extensible and scalable enough to support future requirements that may still be unknown. Healthcare providers need the business intelligence capabilities that will enable them to respond to and get in front of anticipated and unanticipated changes that are expected to occur in this dramatically dynamic market.

## **IBM Healthcare Provider Data Warehouse is the core foundation of healthcare analytics solutions from IBM**



**IBM Healthcare Provider Data Warehouse is a robust set of business and technical data models that are extensible and scalable to fit a provider's unique environment and offers significant competitive advantage.** It offers the ability to create an analytical data store that connects to all of a provider's critical data, across disparate systems and formats, across diverse departments and other data providers. It helps build a dynamic analytics environment where data collected internally and externally is used to determine how to arrange, align, deploy and improve care to patients. It forms the foundation of a true information management infrastructure where trusted, relevant information is available to the people who need it, when they need it, so that they can make better and timelier decisions. IBM Healthcare Provider Data Warehouse:

Can help the healthcare provider build a repository of reliable, accurate and up to date information capable of supplying all of the provider's business and clinical requirements

Can be customized to reflect the exact needs of each provider, including areas that are specific to their business, because it has a strong orientation on both business and I.T.

Can be flexible enough to evolve over time with the ever changing requirements of the Healthcare industry. Open standards makes it easy to build out additional features and accommodate extensions

Can help I.T. staff implement an enterprise data warehouse on time because it contains thousands of hours' worth of development effort and expertise to help business users

Is part of the IBM Industry Models family with over 20 years experience in banking, insurance, telecommunications, retail, and over 500 global clients

# IBM Healthcare Provider Data Warehouse can help answer the questions facing healthcare professionals



## CEO

"I want a dashboard that will summarize existing operations as well as improvements over time."

"I want to reduce lag time from operational event capture to executive level reporting to make timely decisions"

## CIO / CMIO

"I want to enable business users to acquire reports and analytics themselves, to alleviate pressure from constant requests for new data and reports."

"I want the C-Level team to deliver new views, insights and capabilities quickly as requested from department heads."

"I want a solution that helps me address a resource budget that is constantly under pressure and lacks the skills or resources to engineer complex designs across functional domains."

## CFO / COO / Hospital Administrator

"I need insights on how to allocate funds without having to expend significant manual effort."

"I need to be able to model complex resource allocation scenarios and perform what-if analysis outside of operational systems to assess the impact of organizational changes and staff reductions."

"I need aggregated operational metrics both across the health system and by facility and department level."

## Clinical Department Heads

"I need service line specific information in the form of score cards which provide information about quality rankings, quality indicators, department culture, patient safety and training opportunities."

"I need information updated regularly with a 24 month historical comparison."

# IBM Healthcare Provider Data Warehouse benefits and advantages

## **COMPREHENSIVE**

An integrated model across clinical, operational and financial data to enable cross-functional analytics and insights that will drive more informed decisions

## **INCLUSIVE**

Incorporate existing in-house data models and evolve and innovate as needs expand

## **VALIDATED**

Validated industry data model establishes a working vocabulary to accelerate business intelligence design across clinical, financial and technical resources

## **PORTABLE**

A logical data model decoupled from specific technology, portable across data warehouse systems ensuring enterprise-wide adoption

## **INTELLIGENT**

Business Solution Templates address common analytical and reporting requirements such as operational performance and pharmacy utilization

## **COLLABORATIVE**

Provides a gateway between the business language and technical data elements used to deliver your data warehouse, including integration with IBM InfoSphere Business Glossary.

## **TAILORED**

Customizable and fully extensible using data modeling tools to tailor the model to your business' specific requirements

## **TRUSTED**

20+ years of IBM data model design experience supporting more than 500 clients representing large and complex data warehouse and analytics programs

## **REDUCE RISK**

Lower total cost of ownership of platform will minimize risk, project duration and rework

# IBM Healthcare Provider Data Warehouse

**IBM Healthcare Provider Data Warehouse is a family of business and technical data models that accelerates the development of analytical solutions**

**Achieving rapid and successful analytical value requires the proper balance of a comprehensive data schema design across clinical, financial, and operational data elements paired with the ability to support existing models and technologies.** Only a flexible model structure developed specifically for the healthcare industry can support this. IBM Healthcare Provider Data Warehouse provides a glossary of requirements, terms and concepts that can be clearly understood and communicated by both business and IT, thereby helping to accelerate project scoping, appropriate reporting, data quality, data requirements and identifying sources of data. Ultimately, it acts as a blueprint by defining the structures necessary to build an effective data warehouse and provides Healthcare Provider managers with critical pre-built reporting templates that offer a wide and deep view of their business through key performance indicators and other measures.

**As platform independent models, the HCPDW offering is the result of tens of thousands of hours of development effort and deep subject matter expertise** to help business users and IT staff implement an enterprise data warehouse on time and on budget. It provides health care provider managers with critical predefined requirements definitions that offer a view of their business through key performance indicators (KPIs) and other measures.

**IBM Healthcare Provider Data Warehouse Model reaches far beyond simple data gathering.** It offers a significant competitive advantage through the ability to continuously process data, from patient information to medical care utilization, and transform it into information led business initiatives. By unlocking information contained in individual applications and repositories from a variety of vendors and making it readily available to the people and processes that need it, IBM Healthcare Provider Data Warehouse can help get you closer to a true information management infrastructure.

## **Solve complex problems requiring complex data**

Turn operational data into strategic insight with end to end integration of your most valuable data
Build a comprehensive health analytics platform and leverage the investment for years to come
Track improvements and trends in cost and quality over time with historical views and traceability
Provision data in a way that enables detailed analysis by business analytics applications
Leverage existing investments by incorporating existing complex data models into the cross-functional view

## **Turn insights into action**

Integrate clinical and financial data to support emerging care delivery models and deliver reliable and actionable insights to your executive office
Combine resource and clinical information to identify areas of waste and inefficiency that may be inflating the cost of care delivery
Identify actionable opportunities for both clinical and operational improvement by analyzing the patient care data from different perspectives

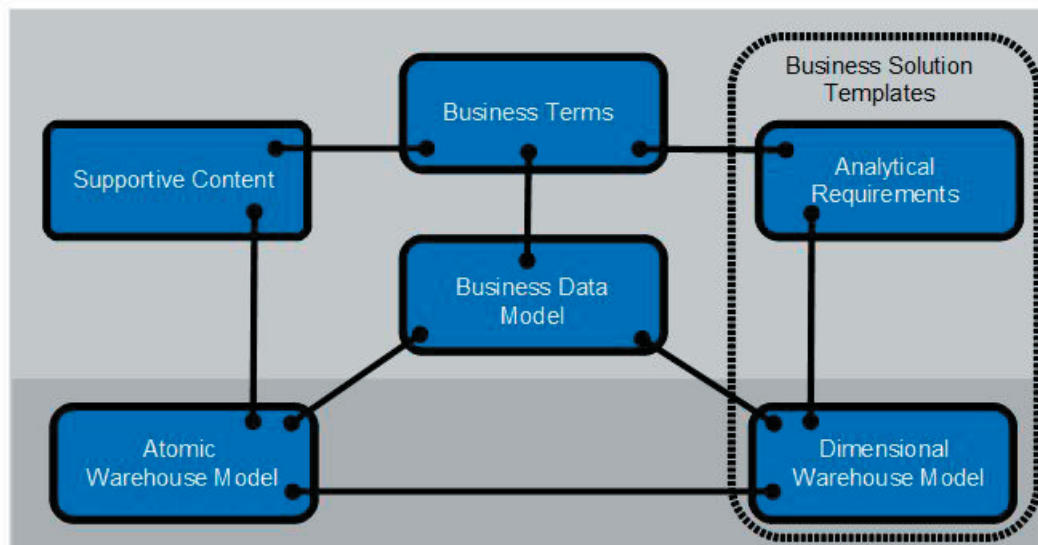
## **Be responsive to your business' changing needs**

Align business and technical resources with a common target and vocabulary to accelerate progress on your initiatives
Increase agility and decrease time to deliver new reports to your decision makers with a design optimized for analytics
Enable department heads with the tools they need to be innovative and collaborative
Adapt to evolving regulatory requirements to maximize reimbursements and compliance
Expand analytical dashboards and reports to include emerging clinical areas without re-implementing an entire platform

IBM Healthcare Provider Data Warehouse contains the following subject areas:

Allergy	Agreement
Business Rule Event	Care Management
Claim	Clinical Order
Contact Information	Diagnosis
Encounter	Financial Transaction
Group & Hierarchy	Location
Party / Party Role	Patient
Patient Administration	Patient Medication
Patient Tag	Person
Pharmacy Intervention	Practitioner
Procedure	Provisioning
Order	Organization
Referral & Authorization	Schedule & Appointment
Specimen	Surgery
Survey	Tenant
Unified Standard Codes	Validity Check

This diagram shows the components of the IBM Healthcare Provider Data Warehouse. Each component is described in more detail later in this section.





## Business Data Model

**The Business Data Model is a logical entity relationship model that represents the essential entities and relationships of the health care provider industry.** It includes common design constructs that can be transformed into separate models for dedicated purposes such as an operational data store, data warehouses and data marts.

The Business Data Model is the first point at which the various business requirements are brought together and modeled in an entity relationship format. It enables organizations to perform the initial modeling of their business requirements and helps the organization understand the various constraints, relationships and structures that can be implied in their business requirements. This is the essential model of the business that provides the overall business context and a common basis for the downstream models that can be used in actual deployment of the physical data warehouse.

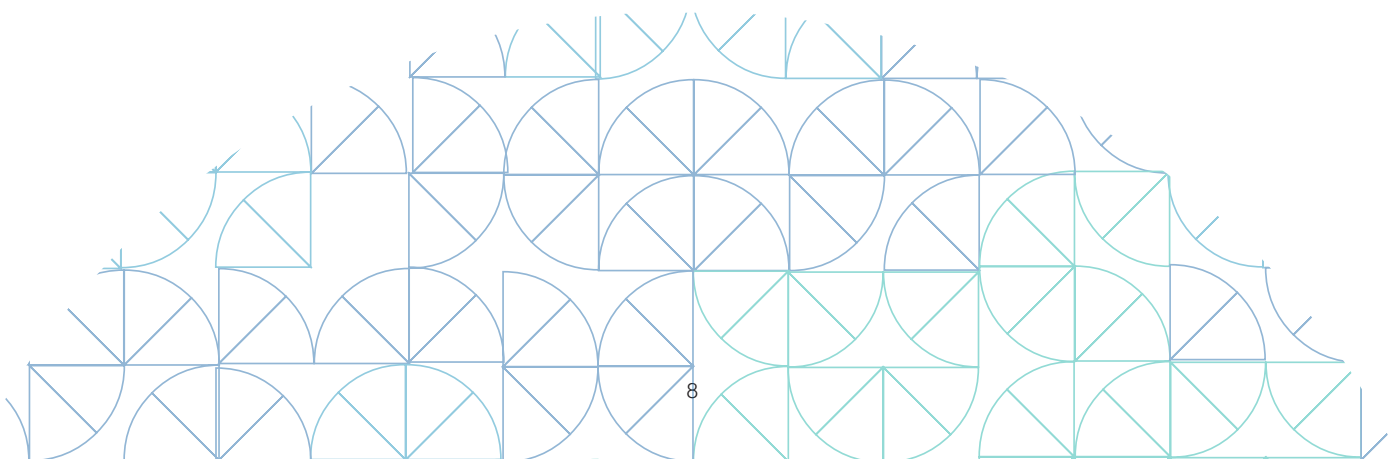
The Business Data Model is not an implementation model. Instead, it includes common logical constructs that can be transformed into the physical structures suitable for dedicated purposes. These derived models are implemented as installed data repositories. The key data concepts of the Business Data Model are based on IBM's experiences, achieved over almost two decades of developing industry models in multiple industries, and customizing them to suit the exact needs of hundreds of individual clients.

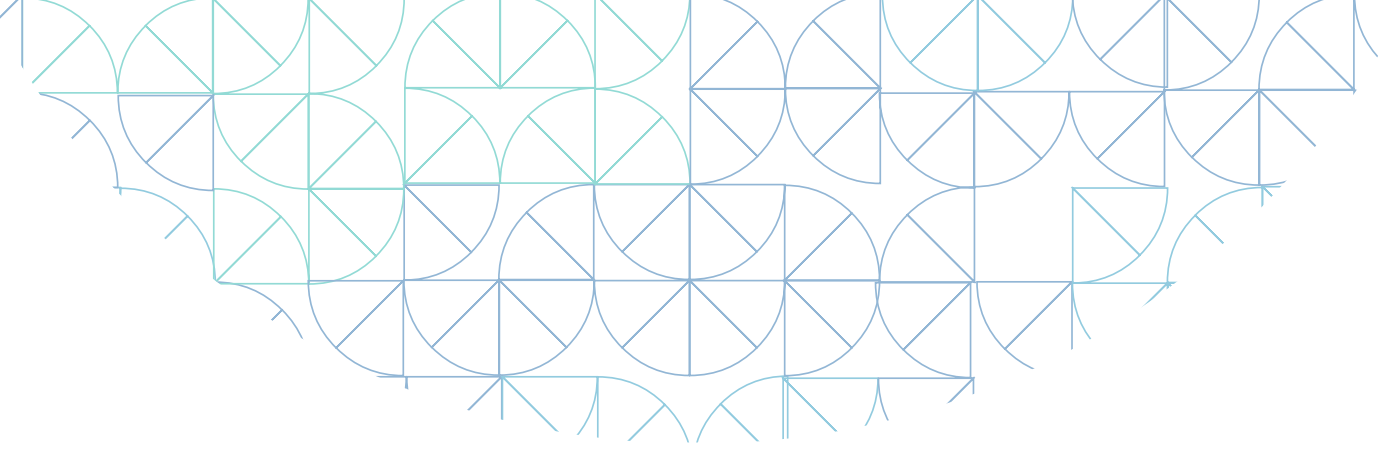
## Atomic Warehouse Model

**The Atomic Warehouse Model is a logical, specialized model derived from the Business Data Model. It is optimized as a data repository which can hold long-term history, usually across the entire enterprise.**

The Atomic Warehouse Model provides the data design support needed to create a uniform model of the enterprise level business requirements defined by the Business Data Model into specific, flexible and efficient structures dedicated to the long-term storage of historical facts. Usage of key concepts, such as Healthcare Event, Role Player and Agreement that are independent of any query usage gives the Atomic Warehouse Model a high degree of flexibility. The history structures have been developed over decades of warehouse design and give the efficient storage construction required. It is also designed to supports near real-time loading of data.

Intended to be the central consolidated store of enterprise data needed for all analytical purposes across multiple business areas, it is a fully defined logical model with more than 300 logical entities and more than 3,200 logical attributes.





## Dimensional Warehouse Model

**The Dimensional Warehouse Model is a logical model derived from the Business Data Model and is an optimized data repository for supporting analytical queries.** The Dimensional Warehouse Model provides the data design support needed to transform the enterprise level business requirements in the Business Data Model into business-specific and efficient structures dedicated to the design of a dimensional data repository. This repository holds sufficient and complete data to meet the needs of business-user-required analyses. Dimensional models are more easily understood by business users. They are optimized for data querying instead of for transactional speed and their structure means it is easier to extend them to support new data requirements. New queries can be created without having to redesign the data structures, and old queries will still operate without change. It is a fully defined model with more than 120 logical entities and 2,500 logical attributes.

Using either the Atomic or the Dimensional Warehouse Model is a valid option for your enterprise data store, depending on your needs. You can use either for the lowest level of data granularity that supports your solution requirements. Collectively, IBM Healthcare Provider Data Warehouse models help to mitigate the risk of implementing a data warehouse, while considerably reducing development time and cost.

## Business Terms

**Business terms define industry concepts in plain business language, with no modeling or abstraction involved.**

Business terms have a set of properties and are organized by business category. Clearly defined business terms help standardization and communication within an organization. Mappings to the data models make it possible to create a common, enterprise-wide picture of the data requirements and to transform these requirements into IT data structures.

Business terms define key business information used for business operations and analysis, enabling users to understand information used by IT assets by allowing traceability between business terms and IT assets. As a consequence, developed IT solutions are driven by business requirements.

Business terms should exclude terms that are not meaningful to a business user, such as terms that are too abstract. Business terms do not model data requirements but capture the data requirements in a simple and flat structure. The modeling activity happens in the subsequent use of the data models when the business terms are modeled using modeling artifacts such as inheritance, relationships and attributes.

Business terms are defined by properties that describe in business language, the meaning of the business term and its status, organized in business categories within a structured hierarchy.

## Supportive Content

**Supportive Content represents data elements in the language of the source requirement.** For example, requirements such as Health Level 7 (HL7), the standard series of predefined data format for packaging and exchanging health care data in the form of messages transmitted between disparate IT systems. The benefit of such a hierarchy is in logically organizing the data requirements into cohesive groupings, and in translating requirement data needs into their support in the data warehouse model.

A key differentiator between Business Solution Templates and Supportive Content is that Supportive Content is less structured (not defined as measures and dimensions, but simply as data elements presented in logical groupings), while Business Solution Templates describe reporting elements.

The purpose of Supportive Content is to capture requirements in a particular domain of interest and then relate Supportive Content to the data warehouse model entities, relationships and attributes that support those requirements. To this end, Supportive Content is defined in the language of the users of the given application. As with usage of Business Solution Templates, the user scopes out the requirements using Supportive Content, which automatically select the most appropriate data warehouse structures using the data warehouse model mappings.

## Business Solution Templates

**Business Solution Templates, incorporating Analytical Requirements and portions of the Dimensional Warehouse Model, enable rapid scoping and prototyping of data marts, which provide a subject-specific analytical layer in a data warehouse solution.** Using the data warehouse modeling software, analysts and business users use Business Solution Templates to quickly gather the reporting and analysis requirements of their organization.

Each Business Solution Template can be divided into measures which are numerical facts that convey quantitative information of importance to the organization and dimensions which then categorize measures.

These measures and dimensions are mapped back to the data warehouse so that the scoping of the reporting and analysis requirements automatically selects the most appropriate data warehouse entities and attributes to support those requirements. The analytics development team can use these Business Solution Templates to create designs for specific data marts or dimensional solutions that can be used as a source for a range of reports and charts.

# Business Solution Templates

**Business Solution Templates help business and I.T. users collaborate when defining reporting requirements**

## Clinical Analytics

**Business Rule Event Analysis** - Pharmacists and infection preventionists have the ability to create clinical rules and receive notifications when patients meet the conditions of these rules. This set of reports allows the user to obtain information regarding the history of patients meeting the clinical rules and notifications generated.

**Patient Safety Analysis** - Pharmacists and infection preventionists review historical lab and medication data in order to monitor organism and resistance trends within the facility. The results of this analysis can be used to determine metrics for stewardship and targeted prevention activities, provide information for internal administrative reporting, and monitor patient safety trends in the patient population.

**Pharmacy Utilization Analysis** - Pharmacists review Drug Utilization by specific order and/or administration to determine which patients or units within their facility have received specific medications. They may also monitor overall drug utilization using the DDD/DOT report to determine utilization trends and in order to decrease specific drug utilization (i.e. high cost medications, resistance.) Interventions are clinical data utilized by pharmacists to track their interactions with other healthcare professionals in regards to recommendations to drug therapy.

**Readmission Analysis** - Readmission following hospitalization is a costly and often preventable event. It has been estimated that readmissions within 30 days of discharge cost Medicare more than \$17 billion dollars annually. A 2006 Commonwealth Fund report estimated that if national readmission rates were lowered to the levels achieved by the top-performing regions, Medicare would save \$1.9 billion annually. This template captures common readmission metrics and dimensionality which could be based on standard or customized rules for exclusions.

**Surgery Analysis** - Surgery Analysis represents aggregations of surgery metrics that describe the makeup of the surgical team, procedures performed, medications used, timing of events, and post-operative care. The analysis can be performed at a number of levels from individual surgery cases or at an aggregated level.

## Operational Performance Analytics

**Inpatient Operational Performance Analysis** - Providers need to monitor and understand the incoming patient flow, patient stay, admission and discharges e.g. How many patients are we seeing? What is the average length of stay? How many outpatient surgeries did we perform and what is the trend? What is the bed utilization and trend?

**Referral Analysis** - Referral Analysis tracks inbound and outbound referrals, as well as intra-system referrals, by reason code. It also calculates revenue leakage due to outbound referrals correlated to that reason code.

**Resource Utilization Analysis** - Scheduling of resource captures information related to the utilization of these resource. A resource could include equipment such as an MRI machine, a location such as an operating room, or personnel such as a physical therapist. Analysis of resource utilization can be used to support equipment purchase decisions, facilities management and staffing levels.

**Survey Analysis** - Survey Analysis contains aggregations of survey responses. Typically the surveys are quality based to poll perceptions and experiences of patients with provider services and/or can represent classifications of respondents and/or responses especially represented by ratios.

## Regulatory Reporting Analytics

**Acute Claim Analysis** - Acute Claims include outpatient Measures - OP, 30-Day Risk Standardized Mortality Rates, 30-Day Risk Standardized Readmission Rates, Agency for Healthcare Research and Quality-AHRQ measures

**Core Measure** - Measures for Inpatient Hospital Data and Outpatient Hospital Data required by CMS (Center for Medicare and Services) and TJC (The Joint Commission).

**Hospital Acquired Conditions Analysis** - The Center for Medicare and Medicaid Services (CMS) recently adopted eight hospital-acquired condition (HAC) measures for the Hospital Inpatient Quality Reporting Program, as part of the 2011 Inpatient Prospective Payment System (IPPS) Final Rule. The eight measures are a subset of the ten HAC categories for which CMS implemented payment provisions beginning October 1, 2008.

**Meaningful Use Analysis** - The Centers for Medicare and Medicaid Services issued a notice of proposed rule-making that outlines provisions governing the Medicare and Medicaid EHR incentive programs, including a proposed definition for the central concept of "Meaningful Use" of EHR technology. In order for professionals and hospitals to be eligible to receive payments under the incentive programs, provided through the Recovery Act, they must be able to demonstrate meaningful use of a certified EHR system.

## Financial Performance Analytics

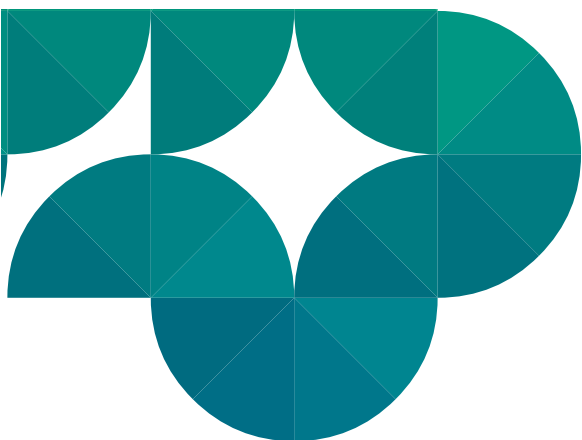
**Claims Financial Analysis** - Providers need to monitor and understand the costs and revenue associated with services. This can be done by aggregating the amounts on claim lines. For example: What is the average purchase price for certain Durable medical equipment? How many units of s DME were put into service? What are the billed vs. approved charges by department? What are the total non-covered charges by DRG.



# Implementing Healthcare Provider Data Warehouse

The Healthcare Provider Data Warehouse promotes an open architecture so your organization can choose what systems to implement on

**Typically, the data structures are not available or accessible to create a broader, innovative analytics data warehouse or business intelligence platform.** Current investments in analytics platforms which were designed to support solely regulatory and quality reporting have started your journey, but they are often engineered and optimized for that purpose. As you move from current tactical needs into the future the data access and consistency across the systems that capture and manage clinical, financial and workforce operations data will probably not speak the same language. More specifically:



The data you need is available in across more than one application, such as the EMR, Claims management or financial systems, but the data cannot be joined across systems that collect the information.

The same data elements may be defined inconsistently, or you may not even have insight into the database the purpose of the system that collects the data - and a significant normalization exercise is necessary to align apples to apples that you can run analytics against.

You do not want to place your agility and ability to innovate in the hands of a single software component - you want to leverage the value those solutions provide - but keep your options open and flexible to implement new scenarios, data sets and analytics as you need them.

**Building a data management infrastructure is a complex team effort, requiring contributions across operational, clinical and financial department heads, business analysts and data architects.** Establishing a common terminology and target model designed for current and future analytics needs can be an expensive and time consuming effort requiring new resources and skills you may not have in house today dedicated to supporting future programs. Often those resources are tied up supporting day to day operational and planning for tactical initiatives.

**A data warehouse is a central repository of summarized data from disparate internal operational systems and external sources.** Operational and external source data is extracted, integrated, summarized and stored into a data warehouse that can be accessed by users in a consistent and subject-oriented format. Data organized around business entities is more useful for analysis than data committed to applications that support vertical functions of the business.

**A data warehouse provides online analytical processing (OLAP) rather than online transaction processing (OLTP).** Users wishing to perform online analyses can access many records per transaction, while OLTP users can only access one record at a time. Analytical users rarely update data and can cope with response times that are not instantaneous, while OLTP users constantly update individual records and expect sub-second response times. An OLAP environment supports analytical queries against data, representing an organization's state at a specific point in time or over a period of time, since support of history is a key element of data warehousing. This type of tool also allows users to drill down to the summarized information for further detail.

**The data warehouse is a single source of consolidated data that provides an enterprise-wide view of the business that becomes the main source of information** for reporting and analyzing data marts that are usually departmental, line-of-business-oriented or business-function-oriented. The data warehouse overcomes limitations of older style decision-support systems:

Complex, ad-hoc queries are submitted and executed rapidly because the data is stored in a consistent format
Queries do not interfere with ongoing operations because the system is dedicated to serving as a data warehouse
Data is consolidated from multiple sources, enabling organization by useful categories such as customer or product.

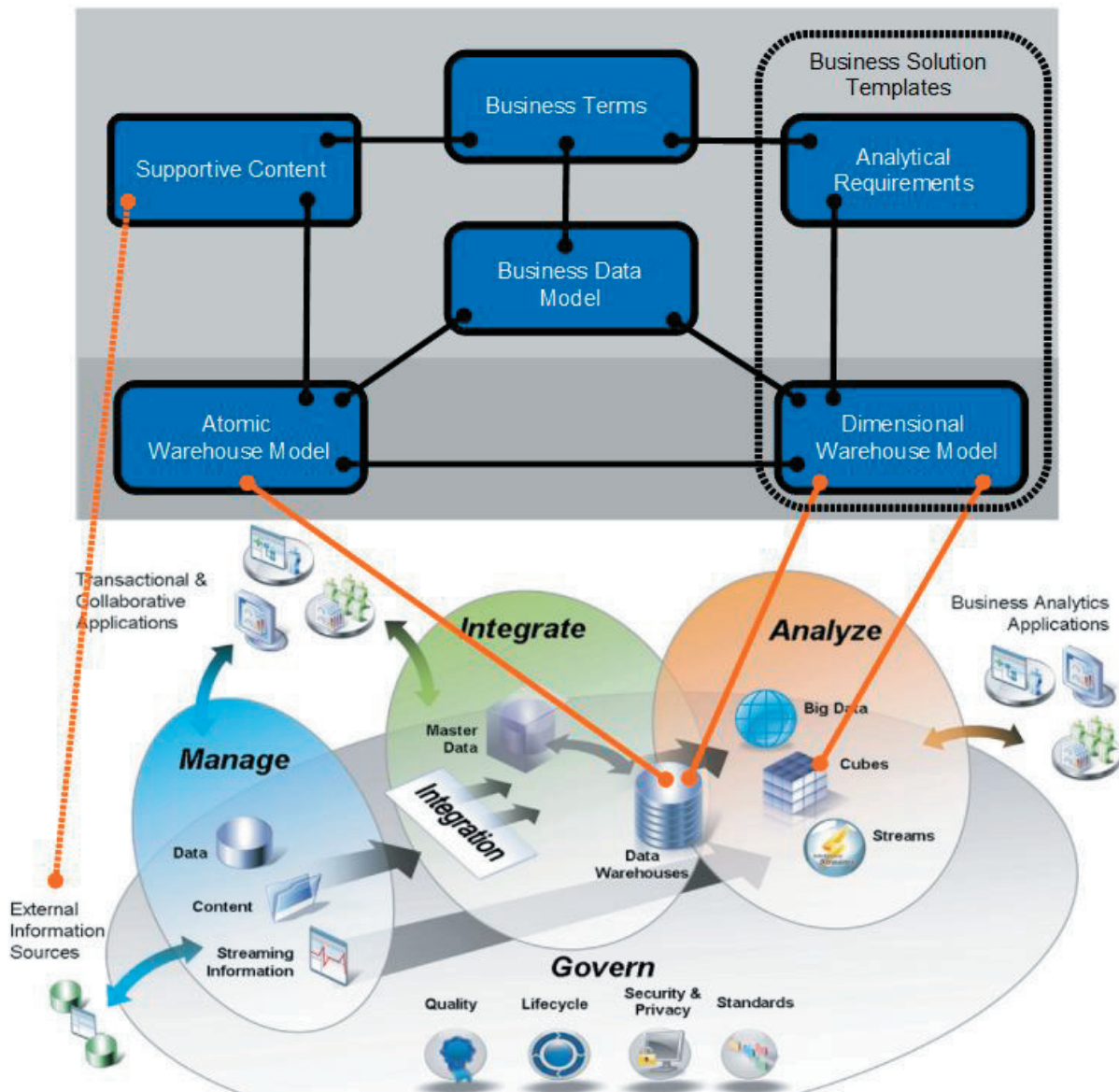
**The data warehouse holds data about the business that can be used as the basis for supporting a detailed analysis of the areas of most concern to organizations today.** This allows organizations to exploit the potential of information previously locked in legacy systems inaccessible to the business user:

Improving population health while managing the cost of care delivery
Identifying new revenue opportunities and marketing opportunities to increase inbound referrals
Isolating loss-leader and inefficient departments and processes as opportunities for outsourcing or process improvements
Driving innovation by introducing new high quality, while cost effective, delivery models
Staying ahead of the competition and preventing patient leakage
Make informed, trustworthy decisions using timely information to forecast the impact of future operational and financial decisions.
Need to expanding to new areas of analytics rapidly, without having to purchase new technology, but have already invested in point in business intelligence and data warehousing solutions - need to leverage what they have while creating a pathway to the future

**The data warehouse promotes an open architecture in which each component adheres to industry standards.** This allows organizations to implement the data warehouse using existing tools or preferred tools. The physical environment of the data warehouse provides organizations with a physical data warehouse infrastructure that is tightly integrated with the logical environment incorporating both the data warehouse model and Business Solution Templates. Organizations can automatically generate the required data structures for a full data warehouse physical environment. Business Solution Templates provide the basis for the design of physical structures that support OLAP Analysis, such as star schemas. Business Solution Templates provide substantial domain expertise to fast start projects, assisting in bringing them to rapid implementation and benefits realization. The use of the data warehouse enables enterprise-wide standard definitions and consistency for all BI data, while delivering this data across the organization on consolidated or multiple platforms. This allows for lower-cost maintenance and centralized control of all data, while retaining flexibility to enable users to select their preferred analytical applications for ease of use, preformed reports or complex analytics capabilities.



## Typical implementation architecture using IBM software



**IBM InfoSphere Data Architect** is a collaborative data design solution that helps you discover, model, relate, standardize, and integrate diverse and distributed data assets. It can be used to manage and extend the Healthcare Providers Data Warehouse models. Using it can simplify and speed up warehouse design, dimensional modeling, and change management by providing a tool to the warehouse data modelers and database administrators to design and manage a warehouse from an enterprise logical model.

**IBM InfoSphere Information Server** is a data integration platform that helps customers understand, cleanse, transform & deliver trusted information to business initiatives including business analytics and data warehousing. It helps to create an accurate understanding of the business context associated with data for Line of Business and a comprehensive understanding of end to end data lineage for better governance.

**IBM InfoSphere Warehouse** is a complete data warehouse platform that delivers superior scalability and availability, design, build, and management tooling, and business analytics. DB2 10 provides a powerful engine for dynamic warehousing with advanced features.



**IBM Cognos** software can provide what your organization needs to become top-performing and analytics-driven. It helps users freely explore information, analyze key facts, quickly collaborate to gain alignment with key stakeholders and plan and act with confidence to drive better business outcomes.

**IBM Smart Analytics System** is a deeply integrated and optimized, ready-to-use analytics solution that provides healthcare providers broad analytics capabilities on a powerful warehouse foundation with IBM server and storage. The IBM Smart Analytics System family offerings span multiple hardware platforms and architectures providing maximum flexibility for deployment. They are pre-integrated and optimized to ensure quick implementation with rapid delivery of value.

**IBM Netezza** provides simple deployment, out-of-the-box optimization, no tuning and minimal on-going maintenance. The Netezza data warehouse appliance has the industry's fastest time-to-value and lowest total-cost-of-ownership. It is a purpose-built, standards-based data warehouse appliance that architecturally integrates database, advanced analytics, server and storage into a single, easy-to-manage system that offers significant performance and scalability.



IBM Industry Models

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